

MGSC Phase III  
*Illinois Basin-Decatur Project:  
Annual Review and Update*

Robert J. Finley, Sallie E. Greenberg  
and the MGSC Project Team

Illinois State Geological Survey  
University of Illinois

DOE Annual Partnership Meeting  
October 2010



Midwest Geological  
Sequestration Consortium  
[www.sequestration.org](http://www.sequestration.org)



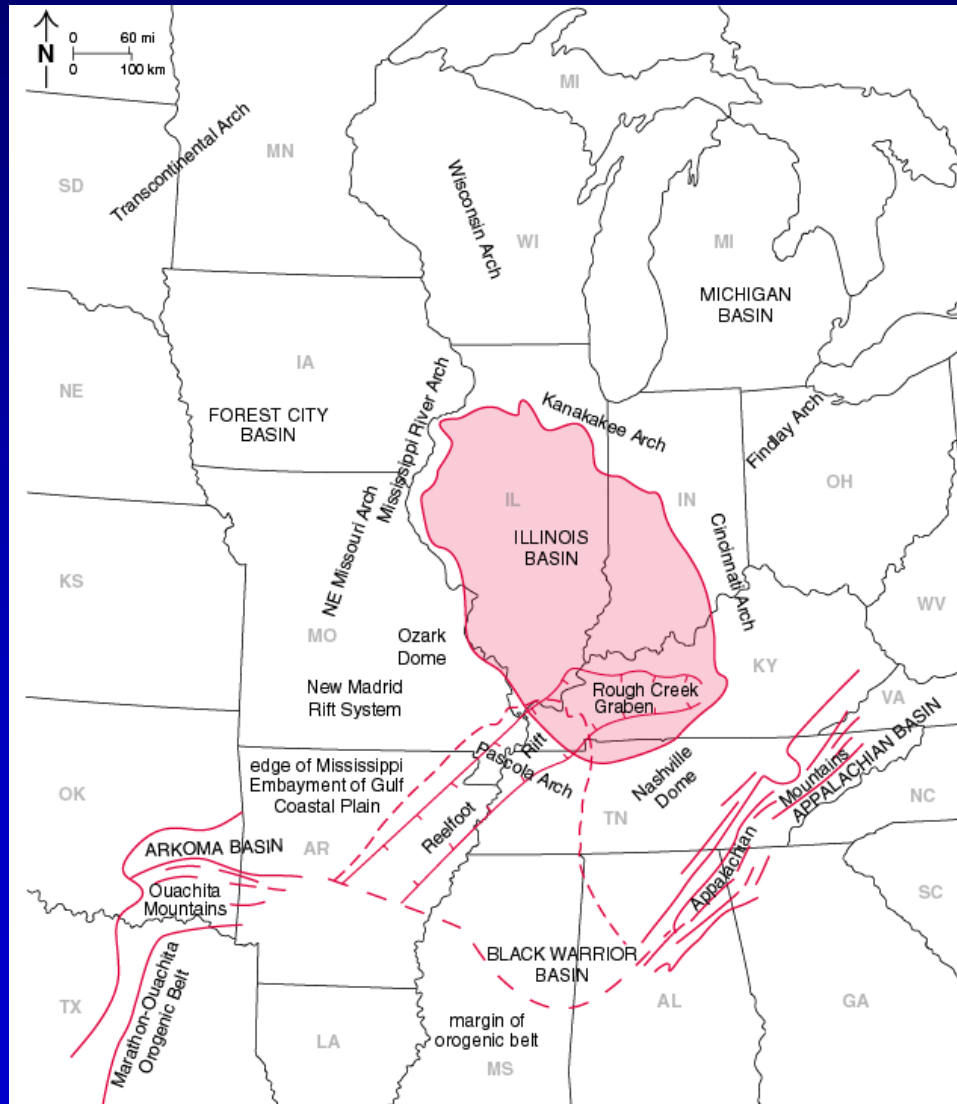
# Acknowledgements

- The Midwest Geological Sequestration Consortium is funded by the U.S. Department of Energy through the National Energy Technology Laboratory (NETL) via the Regional Carbon Sequestration Partnership Program (contract number DE-FC26-05NT42588) and by a cost share agreement with the Illinois Department of Commerce and Economic Opportunity, Office of Coal Development through the Illinois Clean Coal Institute.
- The Midwest Geological Sequestration Consortium (MGSC) is a collaboration led by the geological surveys of Illinois, Indiana, and Kentucky

# Project Phases Within the MGSC Regional Partnership Framework

- Early state-funded assessments began in 2001
- **Phase I** Partnership in place 2003-05 addresses regional geology and concludes that the Illinois Basin likely suitable for geological sequestration; more work warranted
- **Phase II** Conduct three EOR tests and one coal seam injection test (through 2011) and develop saline reservoir test site plan in 2005-07
- **Phase III** funded December 07 and extends through 2016 for injection and monitoring

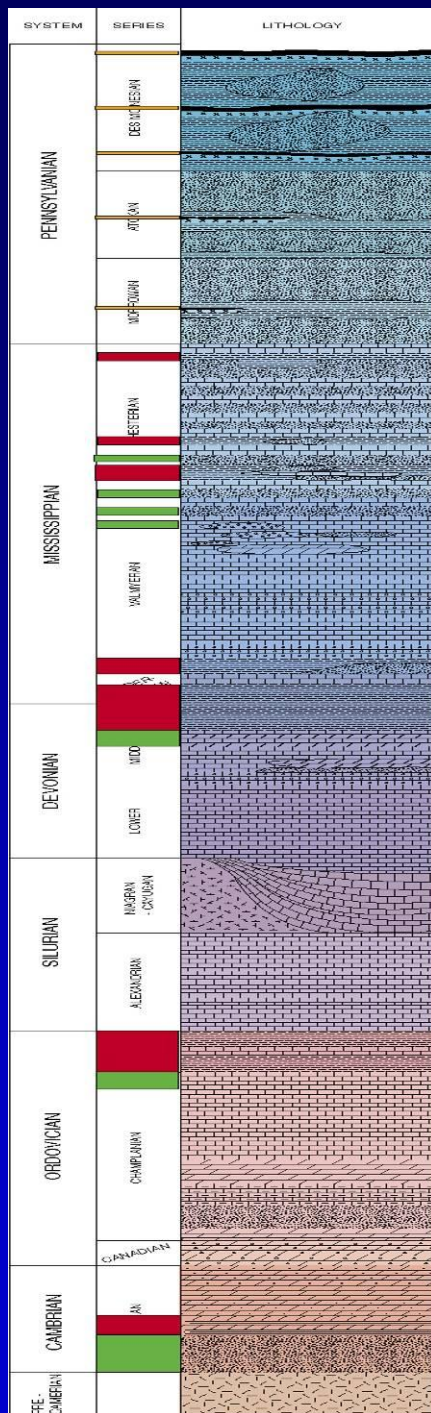
# Regional Geologic Characterization



- Cratonic basin
- 60,000 mi<sup>2</sup> area
- Structurally complex to the south with faulting and seismicity
- 302 million tonnes/year (stationary sources)



# Illinois Basin Stratigraphic Column



**Pennsylvanian coal seams**

**Mississippian**

**New Albany Shale**

**Maquoketa Shale**

**St. Peter Sandstone**

**Eau Claire Shale**

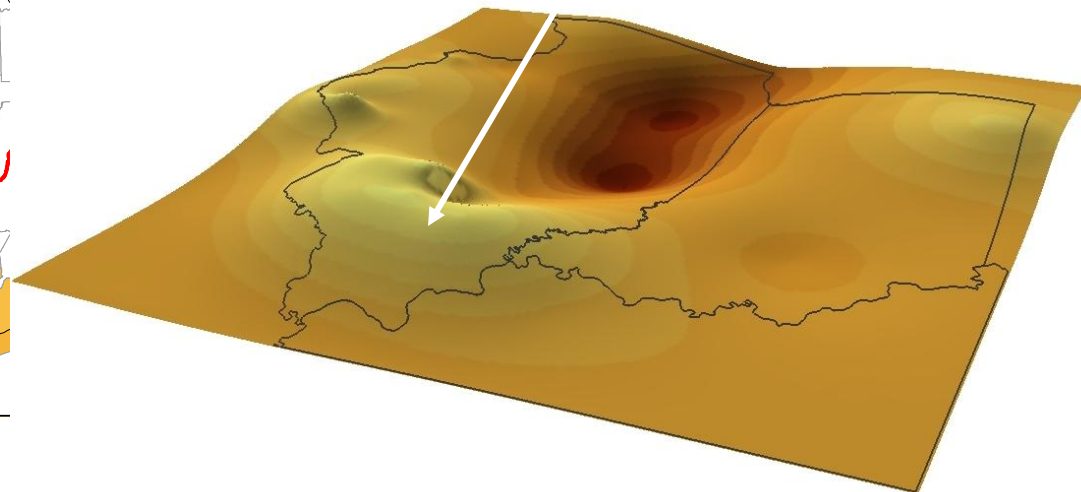
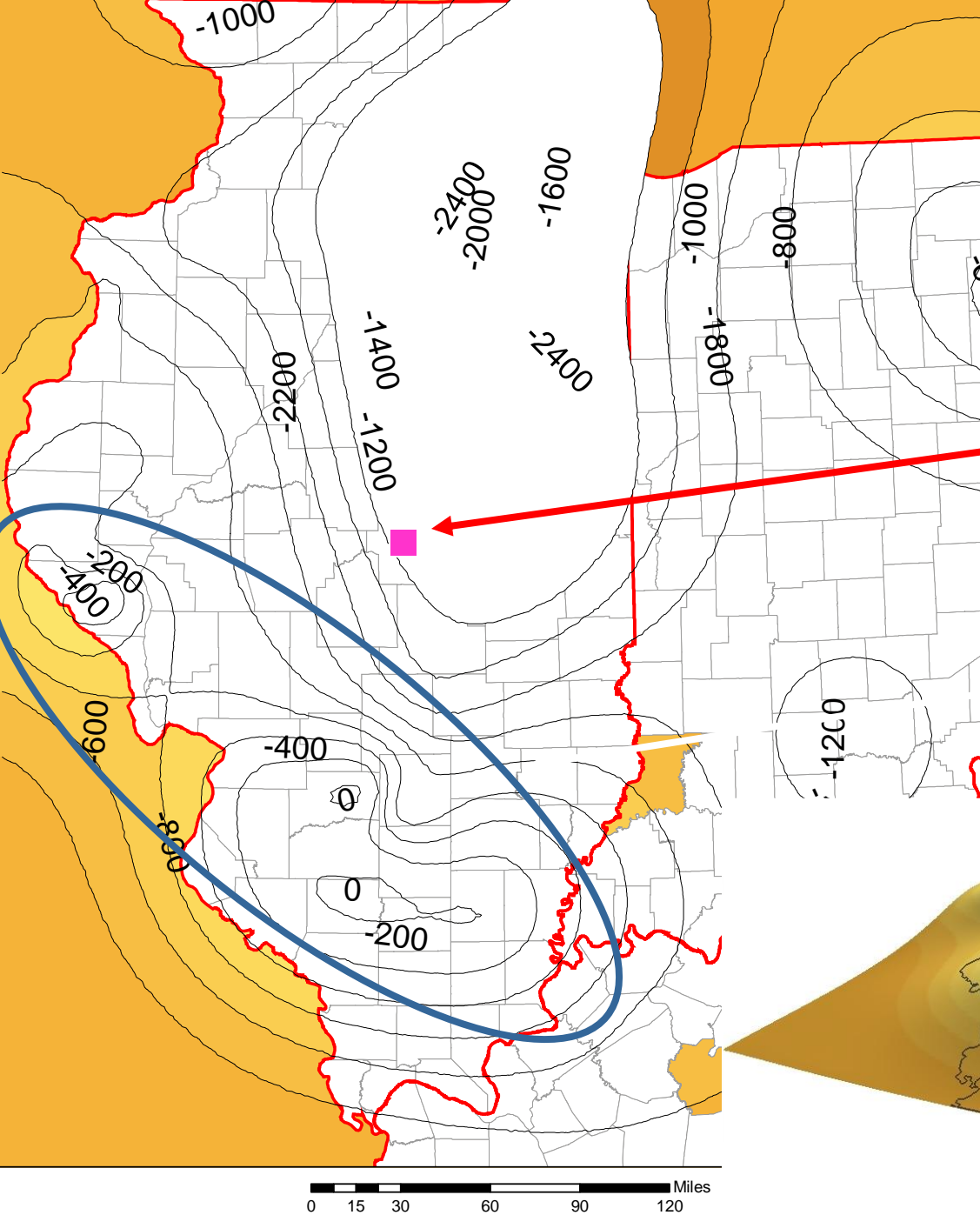
**Mt. Simon Sandstone**

- A collaboration of the Archer Daniels Midland Company (ADM), the Midwest Geological Sequestration Consortium, Schlumberger Carbon Services, and other subcontractors to inject 1 million metric tons of carbon dioxide at a depth of 7,000 +/- ft to test geological carbon sequestration in a saline reservoir

# Mt. Simon Sandstone Isopach

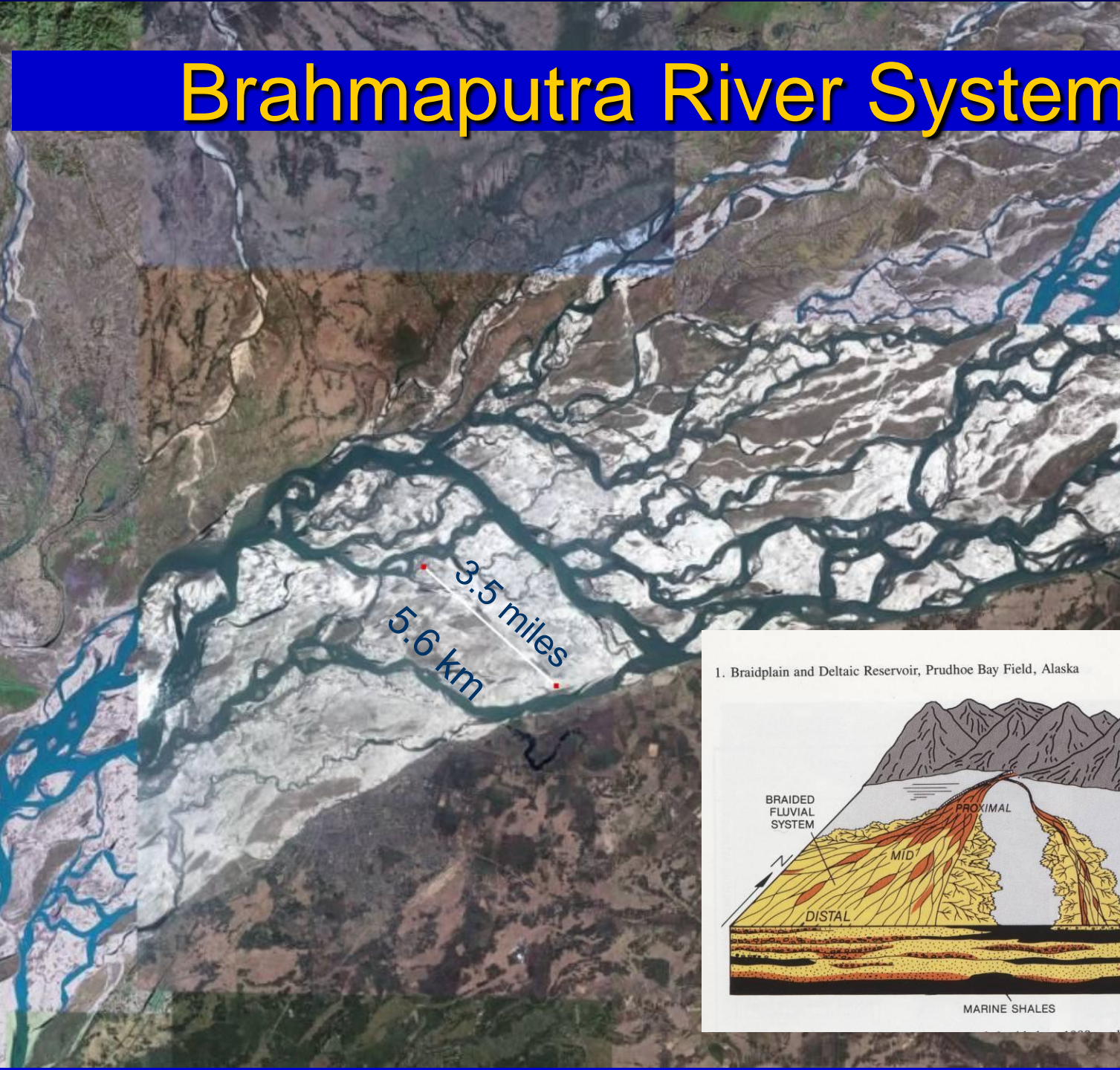
Illinois Basin-  
Decatur Project  
Site

Area of Buried Hills



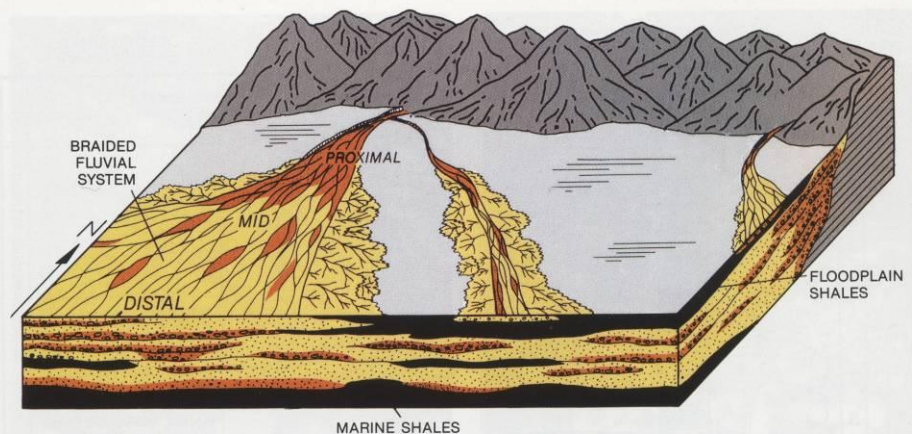


# Brahmaputra River System



1. Braidplain and Deltaic Reservoir, Prudhoe Bay Field, Alaska

13

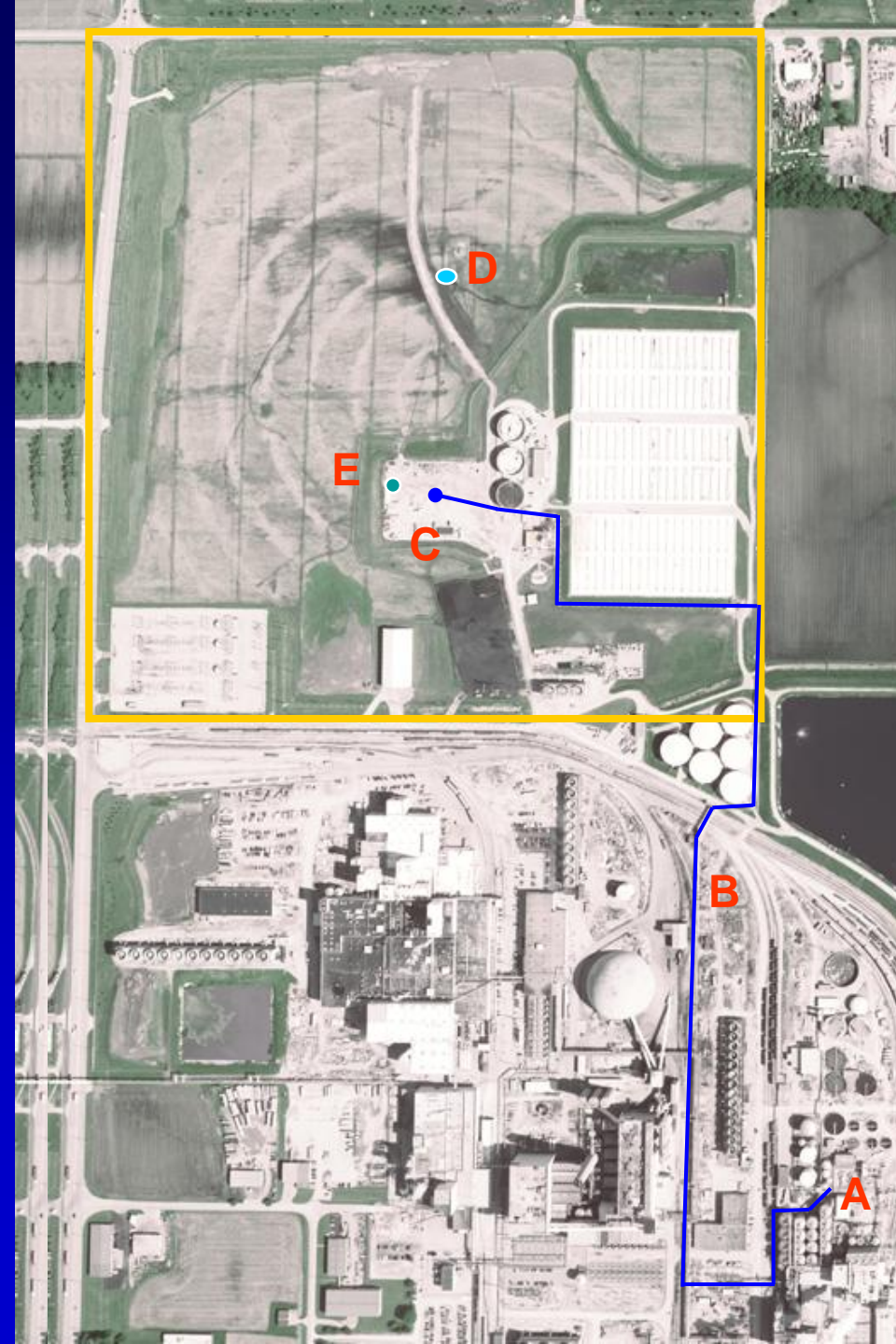




# Illinois Basin- Decatur Test Site

- **A** Dehydration/ compression facility location
- **B** Pipeline route
- **C** Injection well site
- **D** Verification well site
- **E** Geophone well

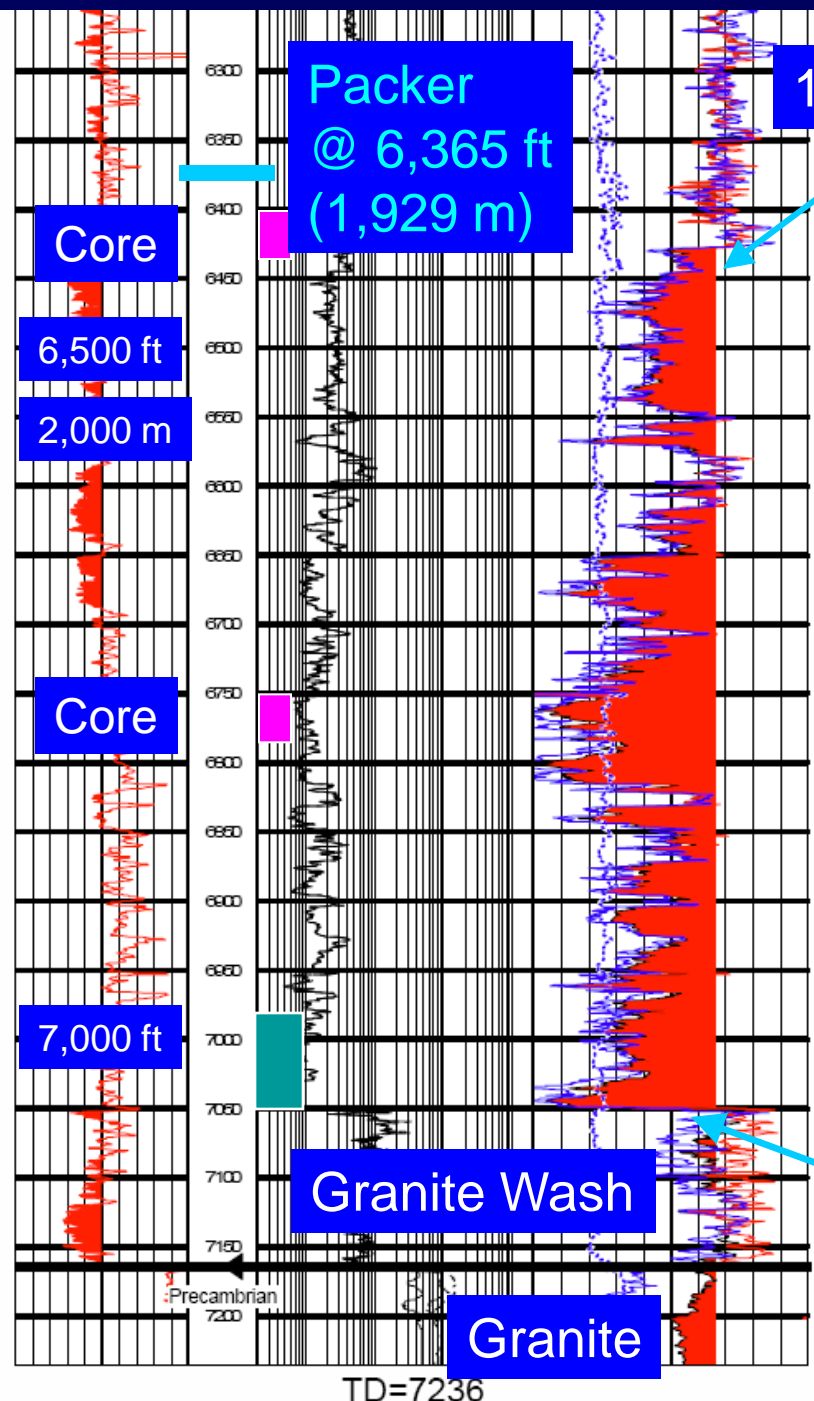
Quickbird Satellite Image: 9/16/2008



# Injection Well Drilled to 7,230 ft (2,190 m) Completed May 4, 2009



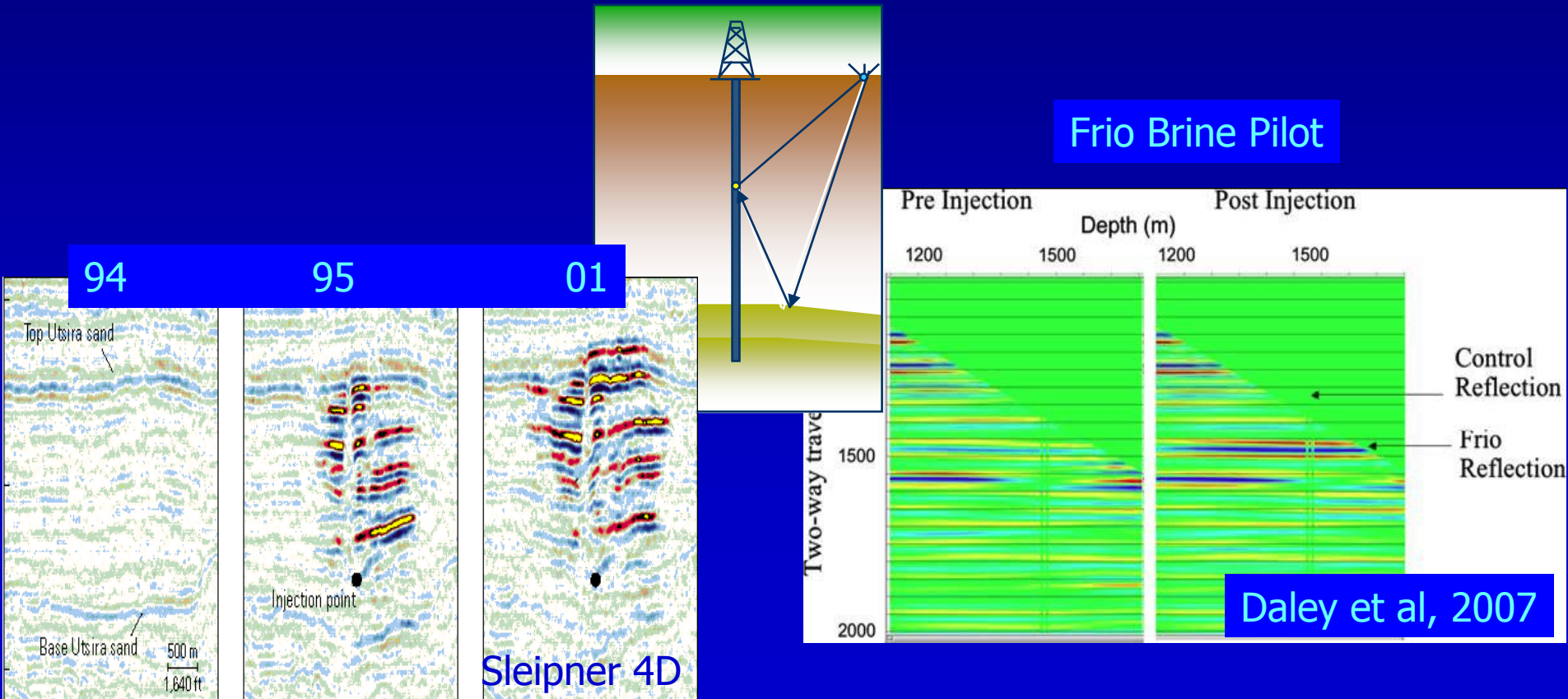






# Plume Monitoring Strategies

- Seismic response of plume based on repeat surface 3D (“4D”) similar to Sleipner project and offset or walkaway Vertical Seismic Profile (VSP) using geophone array



# Geophone Well Completed November 2009

Geophone in special carrier  
strapped to 3.5 (8.9 cm)  
inch tubing



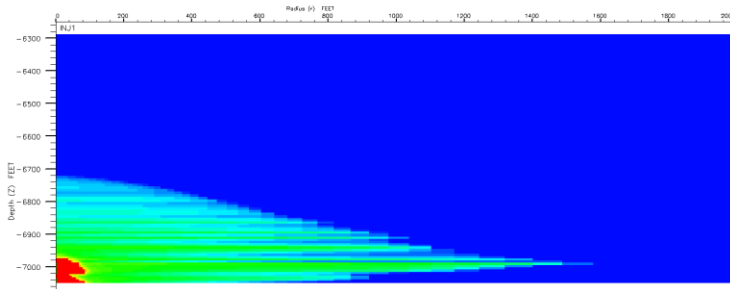
Injection Well

- 3,500 ft (1,060 m) well with 31 geophones cemented into uncased hole on tubing string

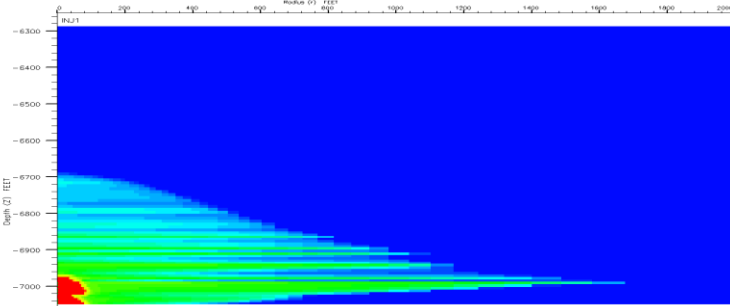
# Plume Monitoring Strategies

## $K_v$ - $K_h$ Sensitivity Analysis (3 years)

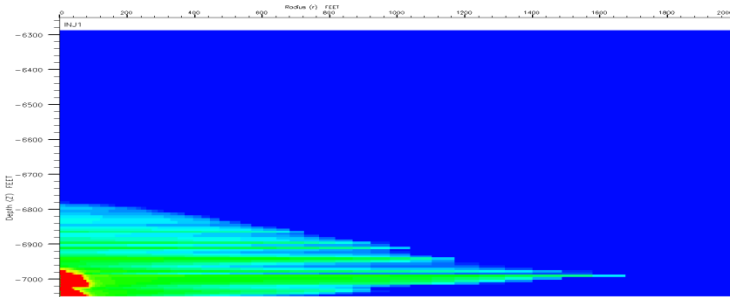
Case 1



Case 2



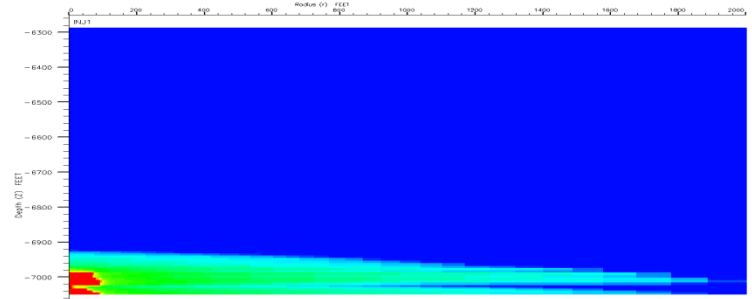
Case 3



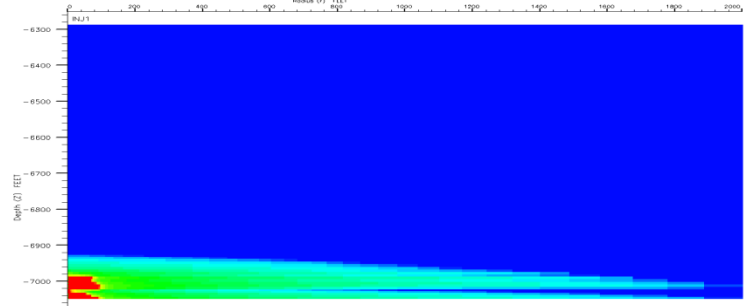
Case 1 : Base Case,  $k_v=0.32k_h$   
 Case 2 :  $k_h=2 \times$  Base Case,  $k_v=0.32k_h$   
 Case 3 :  $k_h=2 \times$  Base Case,  $k_v=0.16k_h$   
 Case 4 :  $k_h=2 \times$  Base Case,  $k_v=0.01k_h$   
 Case 5 : Base Case,  $k_v=0.01k_h$

200,000 ppm

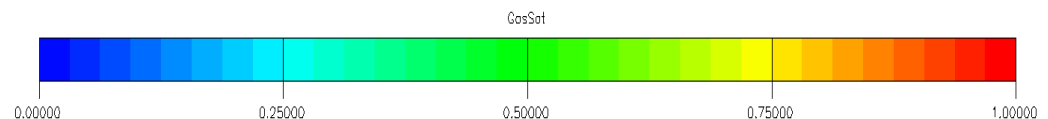
Case 4



Case 5



Case	Plume Radius, ft	Plume Top Depth, ft
1	1560	-6720
2	1640	-6690
3	1640	-6780
4	2000	-6930
5	2000	-6930





# Plume Monitoring Strategies

- Verification well (location **D**) based on surface seismic, VSP, and plume modeling (18 months to CO<sub>2</sub> arrival)

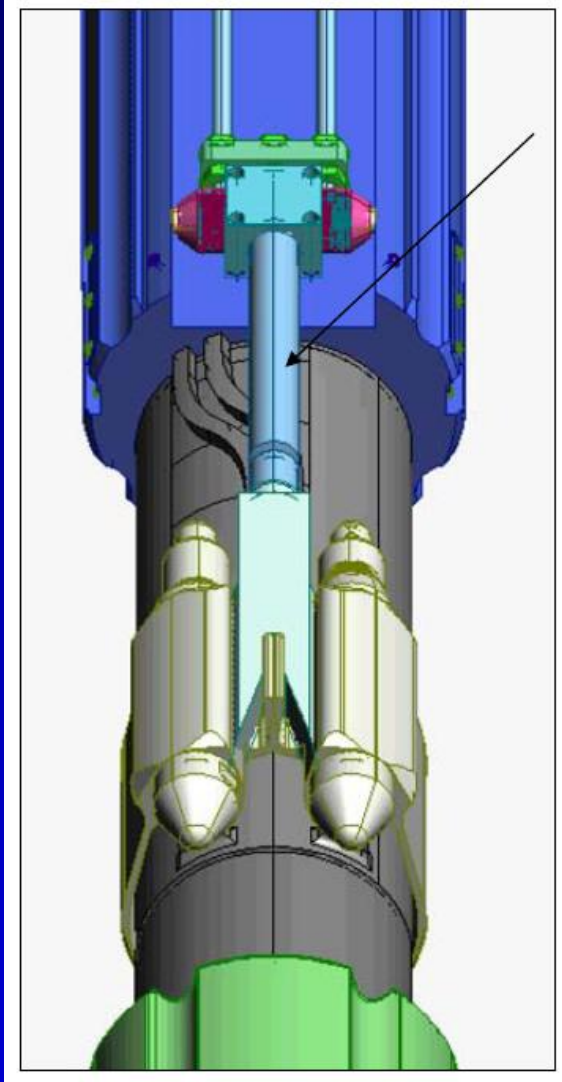


spudded  
September 23 2010

- Open-hole logging and flexible (Westbay) fluid sampling strategy
- Pressure/temp . monitoring
- Cased-hole logging



# Matrix Monitoring Strategies



- Geophones run in on tubing, deployed to casing, avoids cement integrity problems, recoverable as needed
- Map any microseismic events during active injection without interrupting injection process

# Instrumenting Injection Well

- Three microseismic sensors added
- Pressure and temperature sensors added (packer [P,T], tubing [T])

November 2010



# Injection Wellhead Installed and Pipeline Constructed

January 2010



May 2010



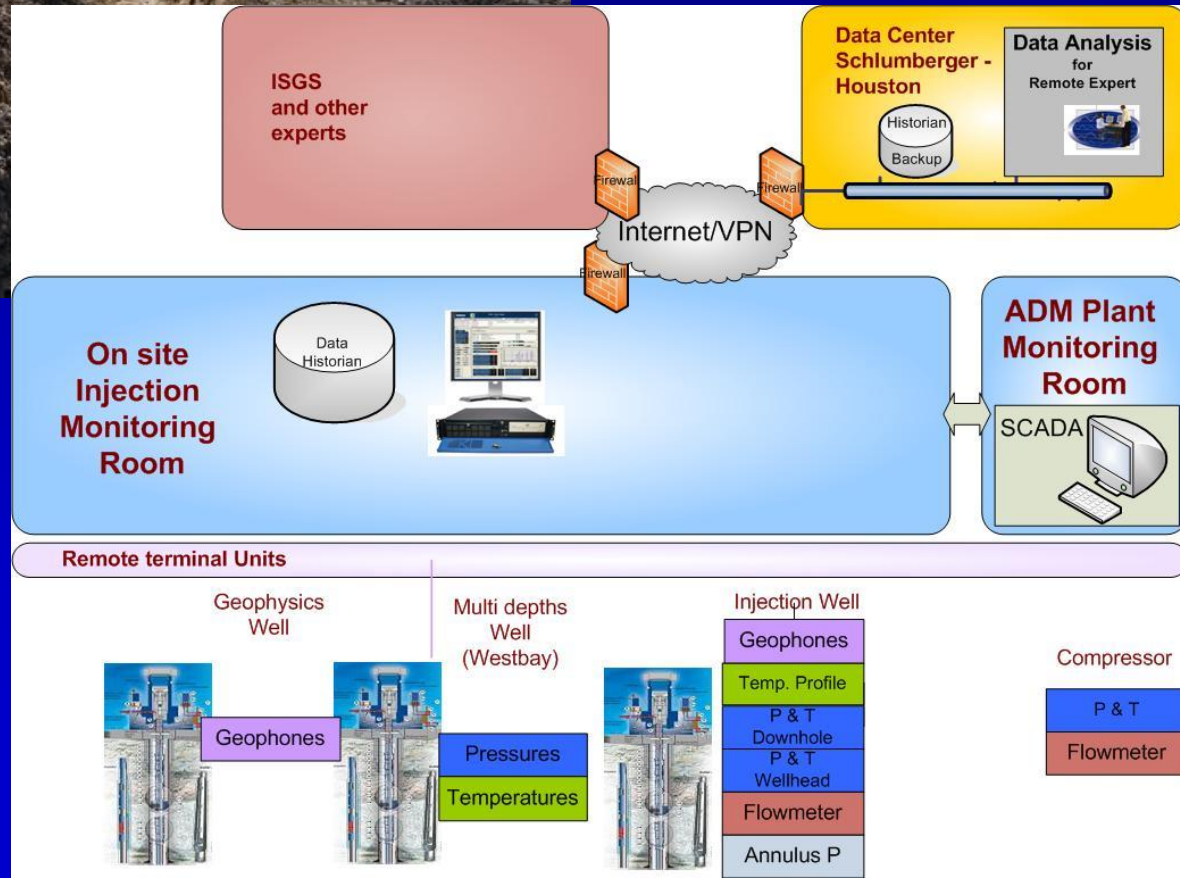
Pipeline Connection

Office/computer room/storage

# Data Network Will Link Subsurface and Operational Sensors

Injection Well

- Real-time remote access
- Multiple backup locations
- Interface with compression facility



# Phase III Project Timeline

## Illinois Basin-Decatur Site:

### Major Elements Completed

- UIC permit application submitted: January 2008
- UIC permit hearing: October 08
- UIC permit finalized: January 27, 2009
- Injection well drilled: February 14-May 4, 2009
- Geophone well drilled: November 2009
- Injection well completed: November 2009
- 3D seismic survey completed: January 2010
- Compression equipment delivered: Mar-Apr 2010



# Environmental Site Monitoring Plan



- Shallow ground water wells
- Electrical resistivity near injection well
- Surface soil flux chambers
- Atmospheric monitoring

Quickbird Satellite Image, September 16, 2008



# Measurement, Verification and Accounting (MVA) at IBDP

- **Light red**: groundwater well
- **Yellow**: soil flux rings
- **Blue**: shallow resistivity points



**Injection well**



# MVA in the Field

- Installing monitoring wells
- Installing vadose zone samplers
- Collecting background samples



EOR formation brine  
sampling

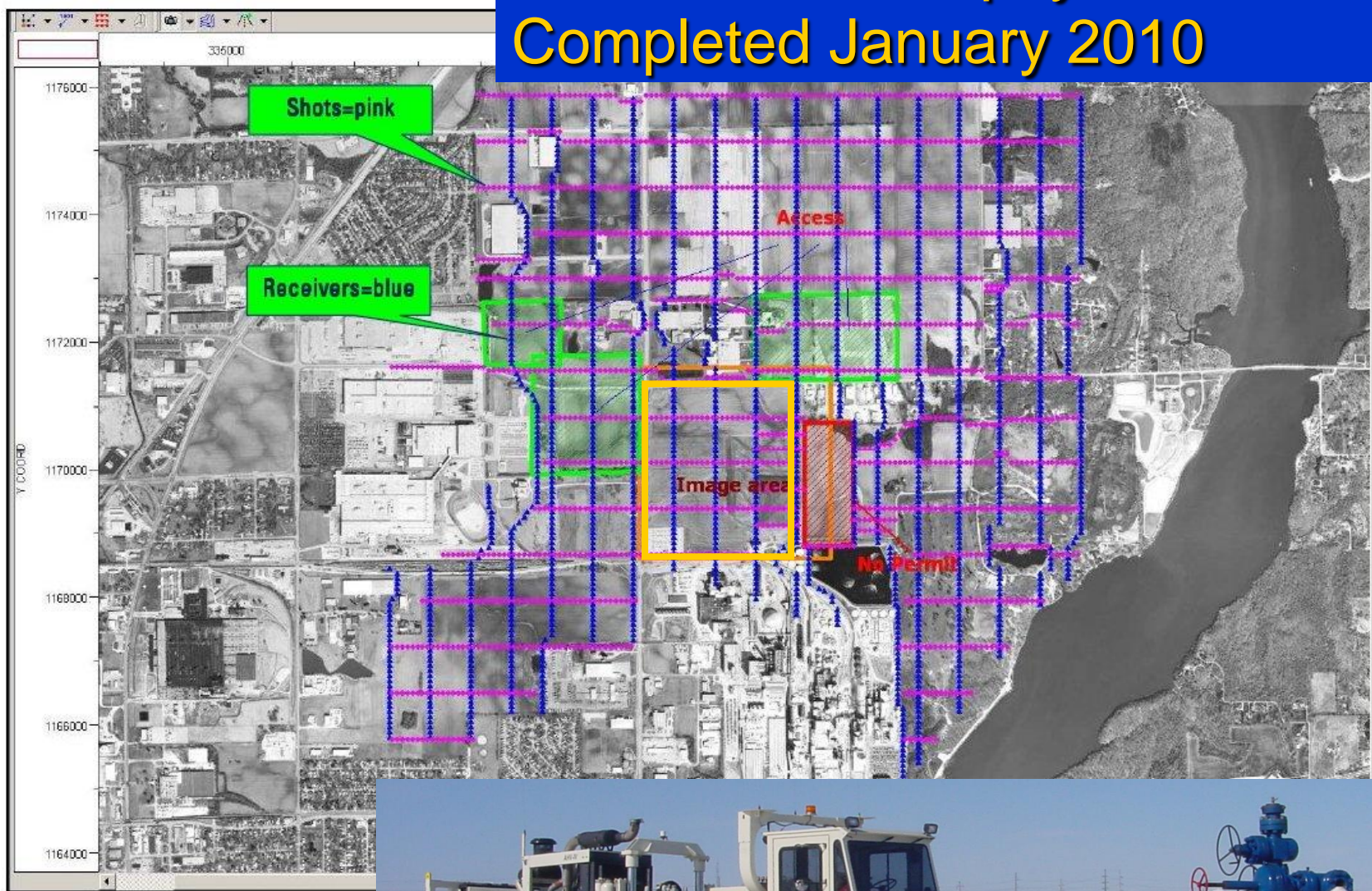


Monitoring well nest



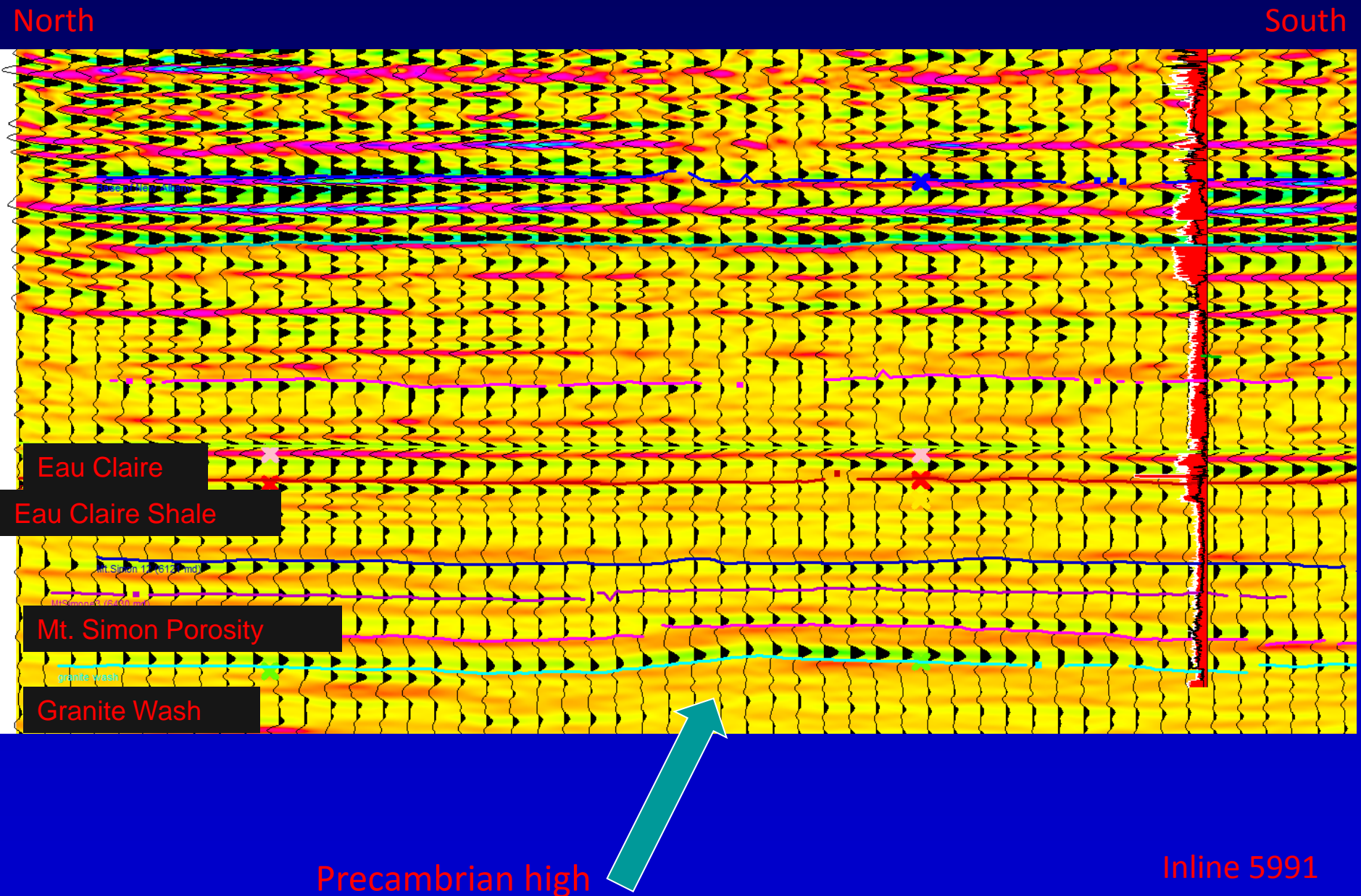


# Baseline 3D Geophysical Survey Completed January 2010



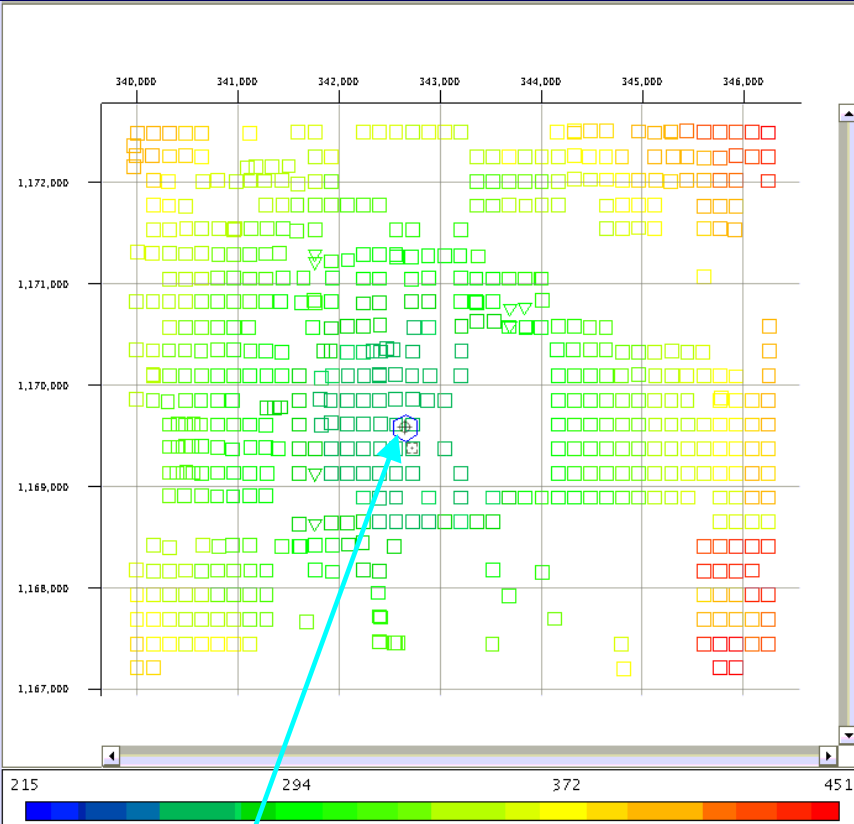


# N-S Inline Through 3D Volume

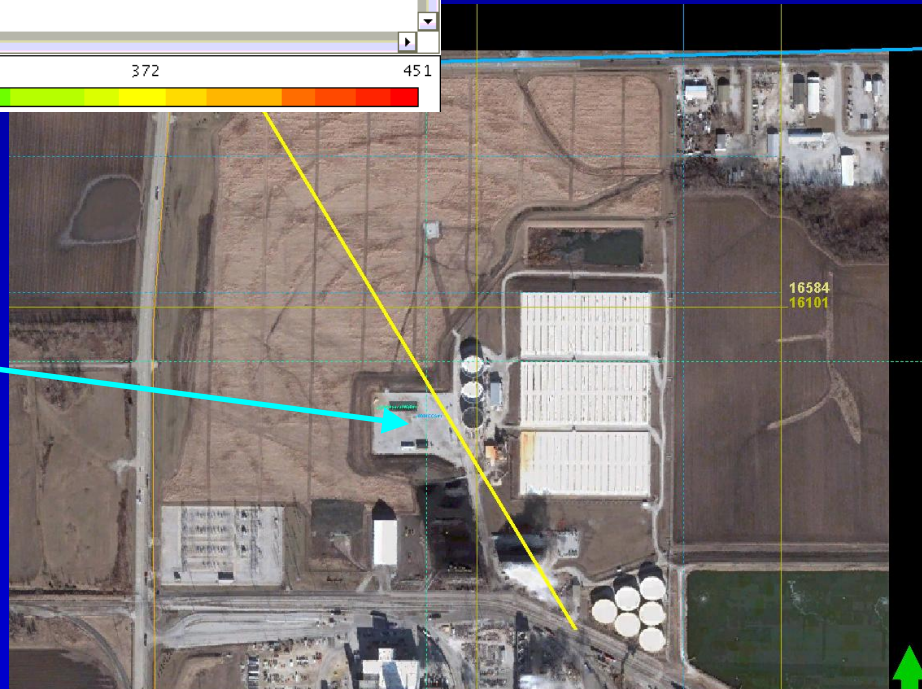


# Line Through 3D VSP Volume

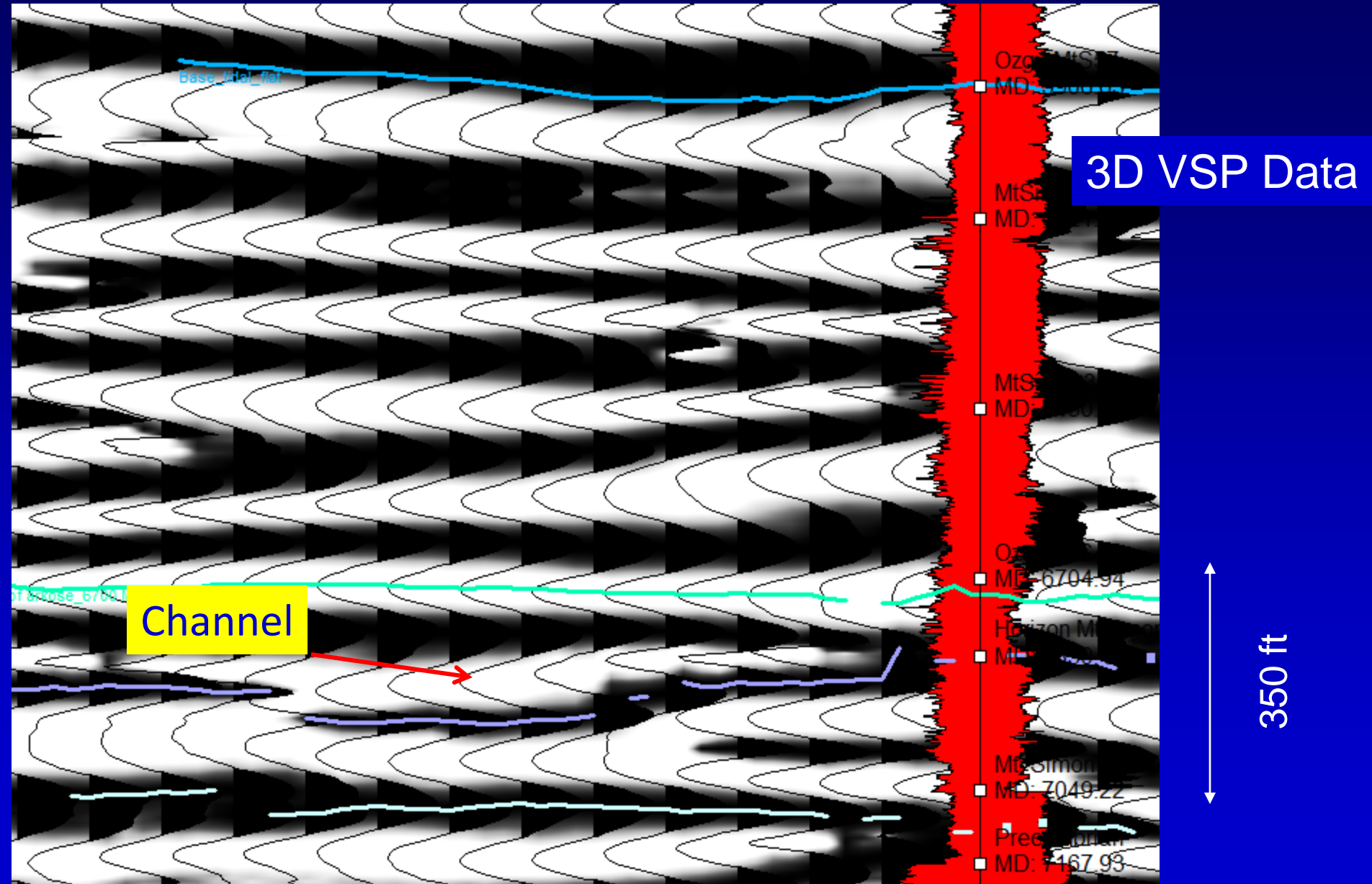
- Data are higher frequency content
- Sensors are subsurface in a dedicated well



Injection Well

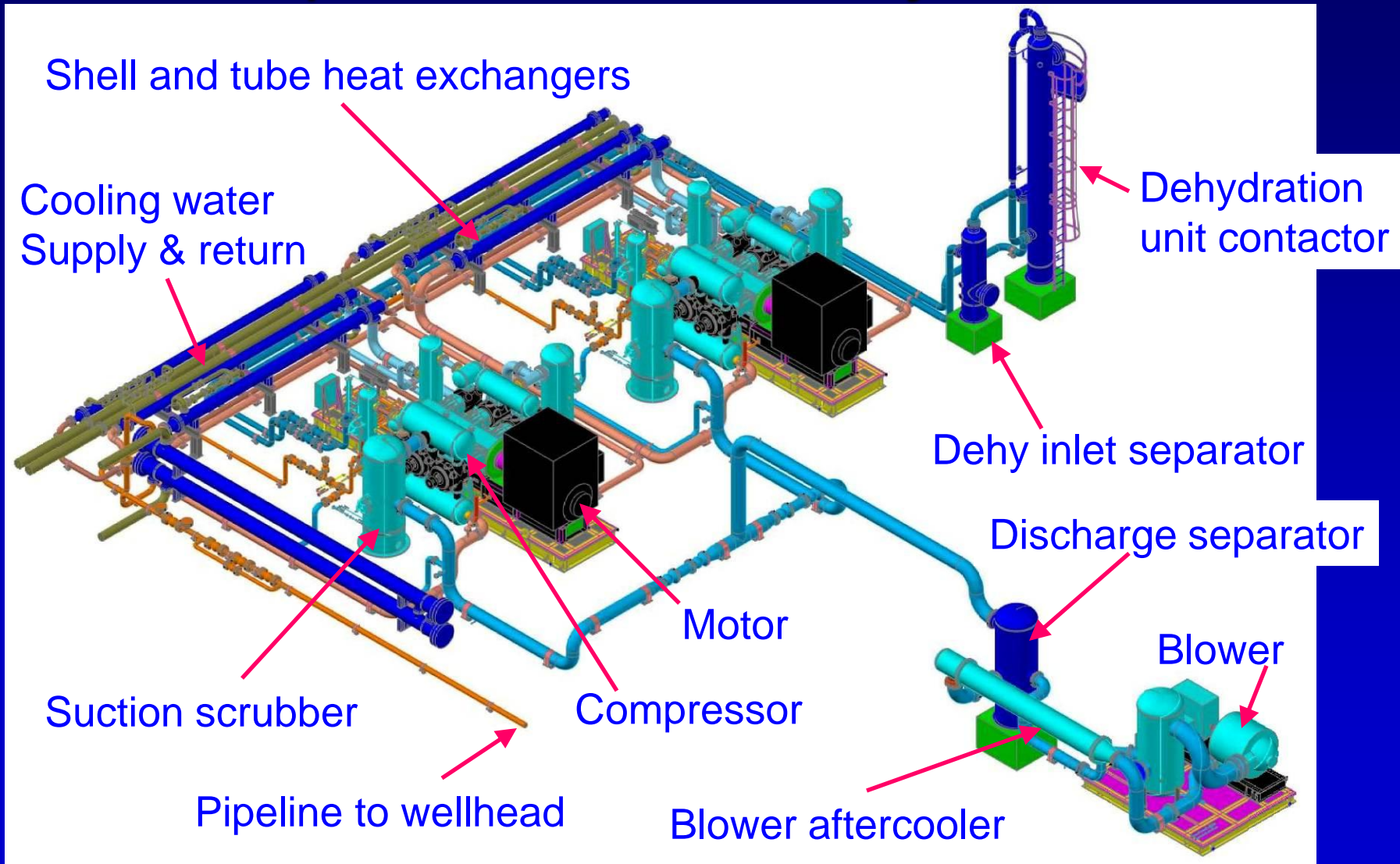


# Possible Channel in Lower Mt. Simon





# Dual 550 TPD Reciprocating Compressors with Dehydration



# Compressor on Transporter in Houston

March 2010



Each compressor skid weighs 132,000 lbs without the motor



# Compressor Installation



March 2010



September 2010

# Blower, Regeneration Skid, and Pump



May 2010



# Remaining Phase III Project Timeline

## Illinois Basin-Decatur Site

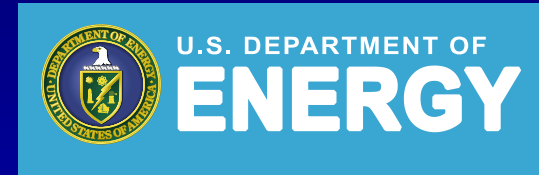
### Major Elements Pending

- UIC permit modification for verification well: submitted October 09, IEPA comments April 10, reply submitted week of May 24, 2010; September comments pending
- Verification well drilling: spudded Sept. 23, 2010
- Compression/dehy facility completion: late Fall 2010
- CO<sub>2</sub> injection period: February 2011-January 2014
- Environmental monitoring: through January 2016

# Additional MGSC Phase III Project Activities

- Reservoir modeling and plume management
- Risk assessment for IBDP
- Outreach, education, and training
- Satellite interferometry for plume monitoring
- Diagenesis of Mount Simon Sandstone
- Small-scale flow structure in the Mount Simon
- Deep-basin structural evaluation





Midwest Geological  
Sequestration Consortium  
[www.sequestration.org](http://www.sequestration.org)  
[finley@isgs.illinois.edu](mailto:finley@isgs.illinois.edu)



ILLINOIS  
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Photo credits: Daniel Byers